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(54) IMPROVEMENTS IN OR RELATING TO VALVE MEMBERS FOR  
 INTERNAL COMBUSTION ENGINES AND TO METHODS OF  
 MAKING SUCH VALVE MEMBERS

(71) We, SOCIETE D'ETUDES DE MACHINES THERMIQUES, a French Body Corporate of 2 Quai de Seine-Saint-Denis, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a valve member for an internal combustion engine and to methods of making such a valve member. The valve member is of the type cooled by fluid circulation and which comprises a valve head and a stem screwed into the said head.

Cooled valve members known in the prior art generally comprise a valve stem which is provided with two intake and return ducts for the cooling fluid, the ducts being longitudinal, coaxial and concentric. The inner duct is generally formed by a tube arranged within the outer duct. The valve stem is screwed into the valve head and is provided with a blind bore in which is mounted the tube forming the inner duct, the valve-head end of which is secured, for example by welding, either to an externally threaded annular nut which is screwed into the end of the valve stem or to a smooth cylindrical endpiece press-fitted into the end of the said stem. In addition, the tube forming the inner duct may be provided with intermediate centring supports bearing against the said bore.

This known configuration of a valve member according to the prior art has several drawbacks due to the fact that the mounting and fastening of the inner-duct tube which is necessarily of a special abrasion-resisting steel is a very delicate operation. In particular, the welded connections of the inner tube require very careful, and therefore expensive working if a service life and reliability which is sufficient and compatible with the normal operation of the engine is to be achieved.

According to the present invention, there is provided a fluid-cooled valve member for an internal combustion engine, the valve member comprising a head having a chamber therein and a stem having a longitudinal axis, the stem being screwed into the head and having separate, spaced-apart, non-axial intake and return tubular ducts there-through for the cooling fluid and which at one end open into the chamber, and at the other end open to the exterior.

The ducts may be symmetrically arranged with respect to the longitudinal axis of the stem.

The ducts may include transverse substantially radial portions which communicate with the exterior.

The present invention also provides a method of manufacturing a valve member as above described, wherein a valve stem having a longitudinal axis is formed by drilling separate and spaced-apart tubular ducts for the intake and the return of a fluid in a bar of circular cross-section, the ducts being drilled substantially parallel with the longitudinal axis of the bar.

The present invention also provides a method of manufacture of a valve member as above-described wherein a valve stem is extruded so as to have at least two separate, spaced apart non-axial tubular ducts there-through.

The present invention thus provides for the manufacture of a valve member cooled by a liquid circulation in a simplified way. It is sufficient to obtain the valve stem by either drilling longitudinal parallel non-axial ducts in a round bar, the bar being obtained for instance by way of machining from a stretched or rolled round bar, or by direct extrusion of a stem having ducts therein, which enables the drilling operation to be dispensed with.

The major drawbacks of the valve members of the prior art, such as welding difficulties, high cost and risk of defective manu-

facture, are therefore avoided. Furthermore, the invention, provides a valve member which has a much simpler configuration, readily allowing several possible embodiments.

Embodiments of the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a partial sectional view of a valve member according to the invention, the stem of which is obtained by way of extrusion;

Fig. 2 is a cross-sectional view on the line II—II of Fig. 1;

Fig. 3 is a partial sectional view of an embodiment of the invention similar to that shown in Fig. 1;

Fig. 3a is a fragmentary view of the free end of another embodiment of a valve stem;

Fig. 4 is a partial sectional view, partly broken away, of an embodiment of the invention having a valve stem provided with drilled ducts;

Fig. 5 is a cross-sectional view upon the line V—V of Fig. 4;

Fig. 6 is a sectional view of another embodiment of the invention; and

Fig. 7 is a fragmentary perspective view of an embodiment wherein the ducts in the valve stem extend helically about the longitudinal axis of the stem.

Each of the drawings illustrates a valve member according to the invention, of the type cooled by fluid circulation and the stem of which is screwed and brazed in a valve head.

Referring in particular to Fig. 1, it is seen that the valve member comprises a stem designated generally by the reference numeral 1. One end of the stem 1 is provided with an external thread 2 co-operating with a corresponding internal thread 3 in a valve head 4. In addition, a sealing fastening 5 is provided by brazing the valve stem 1 in the valve head 4.

The valve head 4 is also provided with a hollow central chamber of cavity 6 into which penetrates the end of the stem 1 provided with the thread 2. The cavity 6 of the head 4 communicates with longitudinal ducts 7 and 8 in the valve stem through transverse ducts 9 and 10.

The valve stem 1 having ducts 7 and 8 is obtained directly by extrusion in such a manner that the ducts are substantially parallel to each other. In the illustrated embodiment the ducts 7 and 8 are arranged symmetrically with respect to the longitudinal axis of the stem 1.

The stem 1 is advantageously extruded in the form of a long cylindrical bar which is then cut into sections which are thereafter machined to the required shape.

The valve stem 1 may also be obtained by way of machining from a solid cylindrical

bar in which at least two parallel non-axial longitudinal ducts are drilled.

In the embodiment shown in Figure 1, the longitudinal ducts 7 and 8 are formed by way of extrusion over the whole length of the stem 1, and therefore each of them opens at the ends 11 and 12 of the stem 1. The longitudinal ducts 7 and 8 are closed at the end 12 of the stem 1 by contact of the end 12 with the bottom of the cavity 6 of the valve head 4, and they are obturated at the end 11 of the stem 1 by an additional, substantially cylindrical member 13 assembled thereto. When the valve member is in use, the cylindrical member 13<sup>b</sup> is acted upon by an actuating rocker. In the present case, the additional member 13 has a circular central projection 14 which co-operates with a corresponding rim 15 provided at the end 11 of the stem 1.

Fig. 3 shows an alternative member 13<sup>1</sup> to the member 13. The member 13<sup>1</sup> has an end 14<sup>1</sup> which co-operates with the end 11<sup>1</sup> of the valve head and is substantially planar and obturates, in the same manner as a cover, the longitudinal ducts 7<sup>1</sup> and 8<sup>1</sup> of the stem. The member 13 or 13<sup>1</sup> is assembled to the stem 1 by welding for example.

Another alternative is shown in Figure 3a, wherein the two longitudinal ducts 7<sup>11</sup> and 8<sup>11</sup> of the stem 1<sup>11</sup> open at the upper end of the said stem and are each adapted to be obturated by sealing plugs (not shown) which are for instance screwed into the end bores of the said ducts. In this case, the rocker (not shown) associated with the valve in use advantageously acts directly upon the end 15<sup>11</sup> of the valve stem.

The longitudinal ducts 7 and 8 of the valve stem 1 (or respectively 7<sup>1</sup> and 8<sup>1</sup>) therefore communicate with the cavity 6 of the valve head 4 through the transverse ducts 9 and 10 and they also communicate with the exterior through transverse ducts 16 and 17 respectively, which are drilled radially into the valve stem 1.

The cooling of the valve member just described takes place for example by passing a cooling fluid *via* the transverse duct 16 to the longitudinal duct 7 and therefrom into the cavity 6 through the transverse duct 9. Thereafter, the fluid is returned from the cavity 6 through the transverse duct 10 to the longitudinal duct 8, the transverse duct 17 serving for the outflow of the said cooling fluid.

In Fig. 4 there is shown a valve stem 111 formed from a bar in which are drilled at least two parallel rectilinear longitudinal non-axial ducts 107 and 108 which open at one end 112 of the stem 101 into a cavity 106 of the valve head 104. In this case, the drilled longitudinal ducts 107 and 108 are blind and do not open at end 111 of the

stem 101. These ducts communicate with the outside of the stem 101 via transverse ducts 116 and 117 and with the inside of the cavity 106 via transverse ducts 109 and 110 respectively. An additional member 113 is placed at the free end of the valve stem 101.

The transverse ducts 109 and 110 connecting the ducts 107 and 108 with the cavity 106 of the head 104 may have various configurations, such as for instance the one shown in Fig. 5 where it is seen that each longitudinal duct 107 or 108 is connected to the cavity 106 of the head 104 by pairs of transverse ducts 109 and 110 respectively. Ducts 109 and 110 extend in spaced-apart planes so as to be superposed without meeting.

A further embodiment of the invention is shown in Fig. 6. A valve stem 201 is provided with four parallel rectilinear longitudinal channels 202 which are arranged so as to be uniformly distributed in the valve stem 201 around the longitudinal axis thereof and which communicate with the central cavity of the valve head (not shown) by means of corresponding transverse channels 203. In this case, use may be made of two longitudinal, diametrically opposed channels 202 as intake channels for the cooling fluid and of the two other channels as return channels for the said cooling fluid.

The presence of more than two channels, for instance of four channels arranged symmetrically about the longitudinal axis of the stem, ensures a uniform distribution and balancing of the thermal stresses effecting the valve stem due to the difference between the intake temperature and the return temperature of the cooling fluid. This reduces the likelihood of thermal deformation, notably the transverse bending of the stem.

Fig. 7 shows part of a valve stem wherein two longitudinal rectilinear parallel ducts 307 and 308 are first obtained either by drilling the stem or directly by extrusion. Thereafter the said stem is twisted so as to cause the ducts to extend helically about the longitudinal axis of the stem. In this case, the thermal stresses affecting the valve stem are substantially uniformly distributed along the longitudinal axis of the stem.

Of course, various modifications may be made to the valves just described. In particular, the arrangement and distribution of the longitudinal and transverse channels may be modified, and/or a valve member according to the invention may be obtained whose stem is made from an abrasion-resisting metal and whose head is made from a different metal.

The valve stem 1 is in contact with the internal face of the bottom of the valve head 4, preferably with a certain pre-stress bearing pressure in order to support this portion of the valve head during the thermal

and pressure stresses to which it is subjected. The bottom of the valve head may be constituted by a wall which is of uniform thickness and therefore has mutually opposite faces which are planar and parallel. However, in order to reduce or avoid the risks of cracking as a result of an excessive concentration of the stresses due to the bearing pressure of the valve stem 1, the wall forming the said bottom of the valve head 4 advantageously comprises a thickened or reinforced central region 18 (Fig. 1) or 118 (Fig. 4) receiving the pressing contact of the valve stem.

#### WHAT WE CLAIM IS:—

1. A fluid-cooled valve member for an internal combustion engine, the valve member comprising a head having a chamber therein and a stem having a longitudinal axis, the stem being screwed into the head and having separate, spaced-apart, non-axial intake and return tubular ducts therethrough for the cooling fluid and which at one end open into the chamber, and at the other end open to the exterior.

2. A valve member according to claim 1, wherein the ducts are substantially symmetrically arranged with respect to the longitudinal axis of the stem.

3. A valve member according to claim 1 or 2, comprising ducts which are rectilinear and arranged parallel to the longitudinal axis of the stem, the ducts being juxtaposed and transversely spaced.

4. A valve member according to claim 1, wherein the ducts extend helically about the longitudinal axis of the stem.

5. A valve member according to any one of the preceding claims, wherein the ducts pass right through the stem and are closed at their end remote from the valve head by a common end piece assembled thereto and forming the free stem-end.

6. A valve member according to claim 5, wherein the end piece has a planar end face which is attached to a planar end face of the free end of the said stem.

7. A valve member according to claim 5, wherein the end-piece has a shouldered portion which is fitted into a corresponding counter-bore or counter-sink in the stem into which open the said ducts.

8. A valve member according to claim 6 or 7 wherein the end piece is welded to the stem.

9. A valve member according to any one of claims 1 to 3, wherein the ducts pass right through the said stem and are each obturated by a respective sealing plug screwed into the end of the duct.

10. A valve member according to claim 9 wherein each plug is screwed into the end of the respective duct.

11. A valve member according to any

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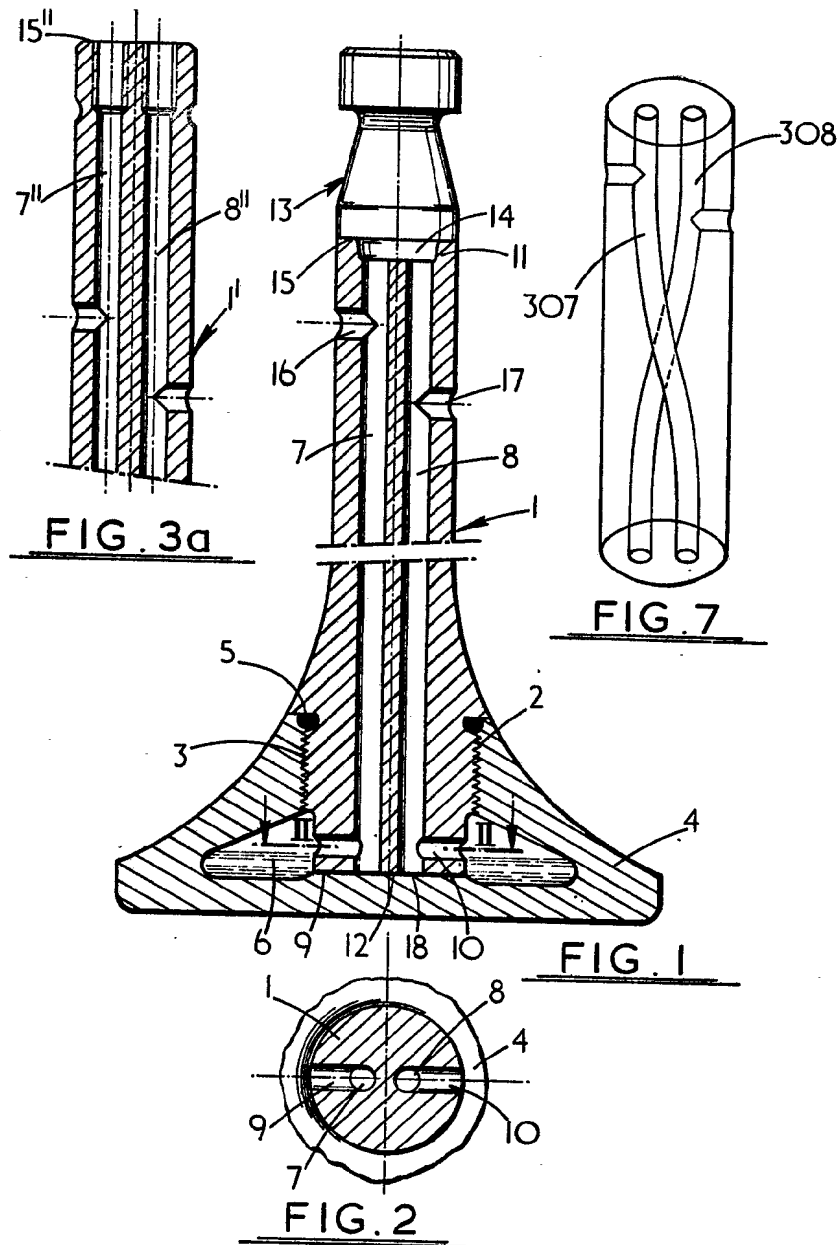
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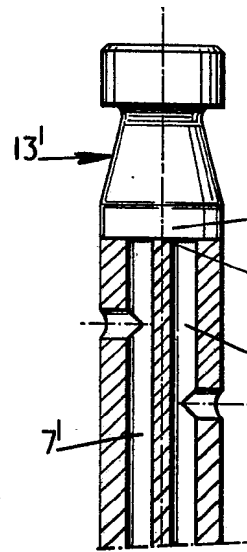
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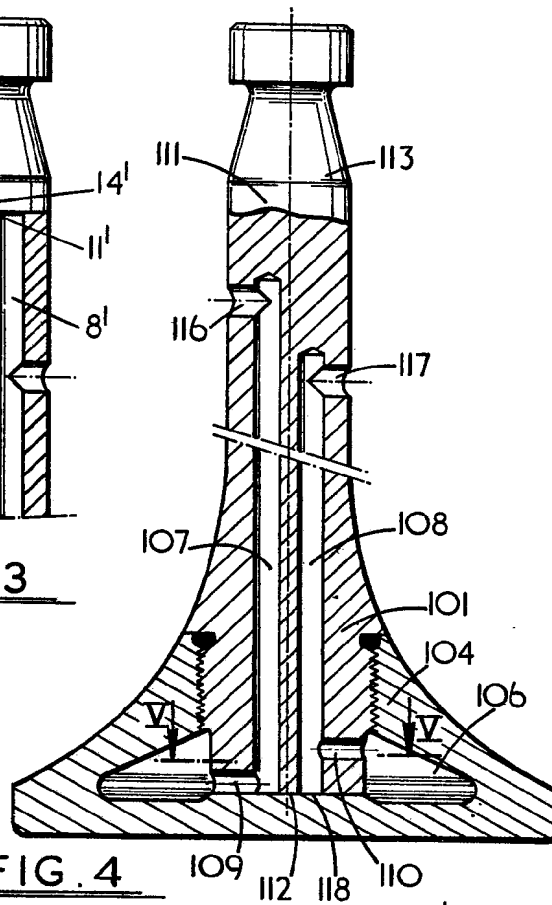
- one of claims 1 to 3, wherein the ducts are blind at one end.
12. A valve member according to any one of the preceding claims, wherein the ducts include transverse substantially radial portions which communicate with the exterior.
13. A valve member according to any one of the preceding claims, wherein there are more than two intake and return ducts for the fluid.
14. A valve member according to claim 13, wherein an even number of intake and return ducts are provided, half being intake ducts and half being return ducts.
15. A valve member according to claim 13 or 14 wherein the ducts are arranged symmetrically with respect to the stem axis.
16. A valve member according to any one of the preceding claims, wherein the central region of the internal face of the wall of the valve head is reinforced or thickened locally.
17. Method of manufacturing a valve member according to any one of the preceding claims wherein a valve stem having a longitudinal axis is formed by drilling at least two separate spaced-apart tubular ducts for the intake and the return of the cooling fluid in a bar of circular cross-section, the ducts being drilled substantially parallel with the longitudinal axis of the bar.
18. Method according to claim 17 wherein subsequent to the said drilling operation, the bar is twisted about its longitudinal axis so as to cause the ducts to extend helically about the longitudinal axis.
19. Method of manufacture of a valve member according to any one of claims 1 to 16, wherein a valve stem is extruded so as to have at least two separate, spaced-apart non-axial, tubular ducts therethrough.
20. Method according to claim 19 wherein the extruded bar is twisted about the longitudinal axis thereof so as to cause the ducts to extend helically about the axis.
21. A valve member substantially as herein described with reference to Figs. 1 and 2, Fig. 3, Fig. 3a, Figs. 4 and 5, Fig. 6 or Fig. 7 of the accompanying drawings.
22. A method of manufacturing a valve member substantially as herein described with reference to Figs. 1, 2, 3 and 3a or 4, 5 and 6 or 7.

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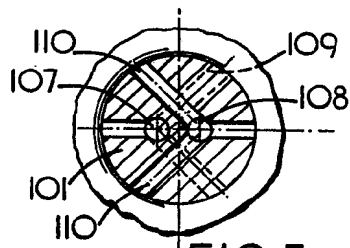




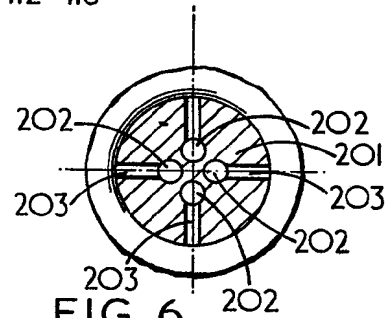
**FIG. 3**



**FIG. 4**



**FIG. 5**



**FIG. 6**